DOCUMENT RESUME

ED 275 913 CE 045 787

AUTHOR Reilly, Patrick L.
TITLE Curriculum Revision Using Advisory Committees and a Modification of the Delphi Technique for Electronic Engineering Technology Programs.
PUB DATE Apr 86
NOTE 86p.; Practicum paper, Nova University.
PUB TYPE Dissertations/Theses - Practicum Papers (043) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Accreditation (Institutions); *Advisory Committees; Associate Degrees; *Curriculum Development; *Delphi Technique; *Electronics; *Engineering Technology; Postsecondary Education; Program Improvement; *Technical Education; Two Year Colleges
IDENTIFIERS Georgia

ABSTRACT

Six state 2-year technical colleges in Georgia were seeking Accreditation Board of Engineering Technology (ABET) approval for a pilot seven-quarter electronic engineering technology program that culminates in an associate of sciences degree. A curriculum revision project that involved a modification of the Delphi technique and input from advisory committee members was undertaken in order to reduce the electronic engineering program to six quarters and ensure that it met minimum ABET standards. Participants were mailed a document requiring them to rank and comment upon technical subjects and subcontent areas. A second document, which summarized the results of the first Delphi round, was mailed to the same participants, and they were asked to rerank subjects and defend rankings that were outside of group norms. After the two-round procedure, a group trend of convergence was apparent, and the process was terminated. Several courses were eliminated and/or revised based upon the recommendations, thereby resulting in an attainment of the ABET-required reduction of the program at a minimum of time and expense. Several possible directions for future research and study were uncovered during the process. (Appendixes to this practicum paper include curriculum suggestions for participant rankings, cover letters, instructions for participants, and the finalized curriculum.) (Author/MN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED275913

CURRICULUM REVISION USING ADVISORY COMMITTEES AND A MODIFICATION OF THE DELPHI TECHNIQUE FOR ELECTRONIC ENGINEERING TECHNOLOGY PROGRAMS

by

PATRICK L. REILLY

A Practicum Report
submitted to the Faculty of the Center for the Advancement of Education of Nova University in partial fulfillment of the requirements for the degree of Master of Science.

April/1986

CE045287

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

P Reilly

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

BEST COPY AVAILABLE

ABSTRACT

Curiculum Revision Using Advisory Commitees and a Modification of the Delphi Technique for Electronic Engineering Technology
Reilly, Patrick L., 1986: Practicum Report, Nova University, Center for the Advancement of Education
Descriptors: Curriculum Development/Delphi Technique/Technical Education/Vocational Education/Engineering Technology/Advisory Committees/ABET/IEEE/Vocational Schools/High Technology

A modification of the Delphi technique was used to implement a revision to a seven-quarter electronic engineering technology A.S. degree program. State technical schools were seeking ABET accreditation and a reduction and revision of the technical curricula was necessary. The Delphi technique was chosen for its advantages when faced with time, funding, and geographic constraints. Advisory committee members and others were selected to participate.

Participants were mailed a document that required them to rank and comment upon technical subjects and sub-content areas. A second document was sent to participants that summarized results of the first Delphi round and required participants to again rank subjects and defend rankings that were outside the group norms. After two rounds a group trend of convergence was apparent and the process terminated. Several courses were eliminated and/or revised based upon recommendations. The required ABET reduction of the program was achieved at a minimum of expense and time but with an increased awareness on the part of participants and educators into the curriculum revision process. Several possibilities for future research and study were discovered.(Appendices include curriculum suggestions for participant rankings, cover letters, instructions for participants, and finalized curriculum.)

Table of Contents

	PAGE
TITLE PAGE	i
AUTHORSHIP STATEMENT	ii
ABSTRACT AND INDEX	iii
TABLE OF CONTENTS	iv
OBSERVER'S VERIFICATION	v
CHAPTER	
I PURPOSE	1
II RESEARCH	6
III METHOD	13
IV RESULTS	17
V RECOMMENDATIONS	19
REFERENCE LIST	21
BIBLIOGRAPHY	23
APPENDICES	
APPENDIX A: Round One Document & Cover Letter	24
APPENDIX B: Round Two Document & Cover Letter	34
APPENDIX C: Delphi Participant Final Survey	42
APPENDIX D: Proposed Curriculum	43

PURPOSE

The State of Georgia is seeking accreditation of six pilot postsecondary vocational-technical schools by the Accreditation Board of Engineering Technology (ABET), a private body consisting of professional engineering societies. These six schools offer a seven-quarter Associate of Science degree under a special provision of the State Board of Education in the areas of Electronic Engineering Technology (EET), Electromechanical Engineering Technology (EMT) and Mechanical Engineering Technology (MET). Part of the provision granting authorization to award a degree includes a requirement that the pilot schools actively seek and receive ABET accreditation within a given time frame or lose that authorization.

This practicum was set in one of these pilot institutions with an enrollment of over 2500 in all programs, including vocational and degree areas. Specifically, the degreed areas are referred to as the "high technology" or "hi-tech" programs and will be so called in this practicum. The hi-tech programs enroll approximately 200 students of which 85 are enrolled as electronic engineering technology (EET) majors. The author teaches in the EET program and is one of four faculty members in the EET Department.

Following almost three years of preparation on a state-wide scale, the hi-tech pilot schools contracted with ABET for a mock pre-ABET inspection of their programs as a prelude to an actual ABET visit to identify strengths and weaknesses. This school was visited by a four-member team from ABET and two Georgia Department of Education (GDOE) observers during the summer of

1985. During the visit, team-members inspected typical student work, texts, curricula, facilities and conducted interviews of faculty, and staff.

The pre-ABET team's written report (personal communication by letter July 14, 1985) was forwarded to this school detailing their recommendations and findings.

The pre-ABET team recommended that none of the hi-tech programs seek official accreditation until several deficiencies were eliminated. Specific to the EET program were the following:

-the physics sequence is a unified concepts based program that may limit transferability of credits to four-year institutions.

-instruction in the written communication skills is weak and needs substantial strengthening.

-an excessive number of hours are being allocated to computer fundamentals compared to other technical courses.

-the curricula are too long and the number of hours a student spends in class is excessive. The program content must be reduced to provide the student with a generalized technical background. A six-quarter sequence for the EET program was recommended by the pre-ABET inspection team.

The ABET-team report also made it clear that the present EET program was ambitious in content but lacked a stronger emphasis upon the "basics" of engineering technology. Instead of the concentration upon many of the so-called 'glamour' subjects of electronics, such as *digital communications, telecommunications,*

etc.. there should be a stronger emphasis placed upon the more generic subjects of electronics. The subjects would be those that every engineering technician is expected to know at a minimum level of competency.

The problem facing the EET department was identification of those courses that would meet the minimum requirements of competency. ABET(1984) has specified certain categorical requirements for a two-year EET degree program:

-program must be a minimum of 96 quarter hours.

-technical courses will be a minimum of 48 quarter hours.

-basic sciences and mathematics, including introductory calculus, will be a minimum of 24 quarter hours.

-social sciences/humanities will be a minimum of 13 quarter hours with at least 9 quarter hours of communications.

-the remainder of the courses should round out the EET program and meet the needs of the engineering technician for satisfactory industrial performance. It is left to the institution to address these additional needs.

Brodsky (1983) noted that nationwide accreditation visits by ABET resulted in citations for lack of a particular course or subject in 39% of the institutions visited with a two-year technical program and in 51% of the four-year technical programs. That same report noted that 7% of the two-year institutions operated at excessive vocational levels and 5% needed program curriculum review.

The formal application for ABET accreditation has been withdrawn by the EET department until the deficiencies listed in the pre-ABET report have been addressed satisfactorily. Since the

bulk of the criticisms point towards the curriculum, a statewide effort was undertaken to revise the current seven-quarter EET program. The results of this practicum constitute the EET department's response to the pre-ABET report.

Reduction of the curriculum would necessarily require elimination of certain courses and reduction of class hours in others. The author felt that while the EET department faculty can be considered the experts about the broad field of electronic engineering technology, their limited recent industrial experience would introduce inaccuracies into the curriculum revision process. The EET Advisory Committee would better serve to provide the needed input as to the "currency" of a given subject since the committee is composed of engineering professionals employed by local industries. The committee has been a standing body for over ten years and meets quarterly with the EET department faculty.

By using the advisory committee as a source of what local industry needs in its engineering technicians it was hoped that the reduction of the EET curriculum would result in a solid foundation of technical knowledge for the student with a minimal burden placed upon the employer for additional training. At the same time, the reduced curriculum would satisfy ABET (1984) requirements.

The advisory committee's suggestions were compared to suggestions made by the EET department faculty to identify those courses thought to be relevant by the faculty, yet not relevant to the advisory committee members. The committee's suggestions

called for increased emphasis upon the fundamental courses of study with less concern upon the elective type courses. Comparison of these suggestions with those of the EET department faculty were made using the document in Appendix A. The document reflects the suggestions of the EET department for a typical six-quarter program.

Those courses and content areas that received a majority (65%) of favorable responses from the participants were included in the recommended six-quarter program. Rankings from three (3) to five (5) were considered favorable rankings. The participants were asked to make comments to support their disagreement with the faculty suggested courses and content areas. When the results of this initial session, or *round*, were tabulated the participants were asked to again rank only those courses and content areas where disagreement existed. Previous comments by the participants were provided for their review.

At the end of this second round a consensus of opinion existed among the participants and a third round was not necessary.

During a de-briefing meeting scheduled at the conclusion of this practicum the participants were asked to complete a survey document (Appendix C) that solicited their opinions of the entire practicum.

RESEARCH

This practicum used a forecasting consensus technique as a vehicle for curriculum revision. The technique has come to be known as *Delphi*, after the mythological Greek oracle. A review of the limited published literature suggested a utility for curriculum revision through use of the Delphi.

Hass (1980) has described a dynamical and self-renewing image of the curriculum revision process that consisted of four steps:

(1) Identification of the context in which curriculum implementation will occur. Context identification will entail data collection about learners and the various sociological variables with which the learners interact.

(2) Setting goals or determining objectives. Based upon the data collected in the first item, specific objectives for the intended learner are developed to co-exist with more generalized curriculum objectives.

(3) Selecting, preparing, and implementing strategies to achieve the curriculum changes intended as defined by the goals. Identification of available strategies and their selection is to be based upon the objectives and can be identified from the four bases of any curriculum,i.e., social forces, human development, learning natures, and knowledge/cognition.

(4) Evaluation. What has been accomplished in terms of the goals and objectives must be evaluated to provide information regarding learner achievement and performance. The evaluation will also yield information that will provide the basis for

reexamination of the curriculum, objectives, goals, and intended learner. There will be more evaluation following these revisions.

The EET Department is currently at the fourth step of this dynamical process and sought additional inputs from its advisory committee. Past self-reliance upon faculty member inputs alone has been called into question by the pre-ABET report (personal communication by letter July 14, 1985). Faculty inability to predict the usefulness of proposed curriculum changes due to technological outdatedness had been noted by the pre-ABET team members, therefore the advisory committee's constant exposure to changing technologies was seen to be an ideal characteristic necessary for suggested curriculum changes.

The use of advisory committees in the curriculum revision process is appropriate and also closely examined by ABET. In the 1983 report cited earlier by Brodsky, 15% of the two-year institutions studied and 31% of the four-year institutions were judged to have inadequate industrial advisory committees. It is interesting to note that the majority of the sixteen items detailing the major functions of advisory committees compiled by a study of North Carolina advisory groups and reported by Parry-Hill (1981) were concerned with curriculum processes:

(1) Offer advice on course and program development;
(2) Recommend course and program revisions to keep the curriculum relevant;
(3) Recommend equipment for use in programs;
(4) Assist in the formulation of goals and objectives in programs;
(5) Encourage local public support of programs;
(6) Assist in the evaluation of programs;
(7) Assist graduates in securing employment;
(8) Assist in student recruitment;
(9) Assist in long range program planning;
(10) Advise on facility construction and/or renovation;
(11) Assist in faculty recruitment;

(12) Provide for consumable classroom supplies;
(13) Provide scholarships and other student financial aid;
(14) Evaluate effectiveness and work of the curriculum advisory committee;
(15) Advise in planning needs for the handicapped and disadvantaged; and
(16) Provide awards to outstanding students and/or faculty.

If the EET department advisory committee was to be used for curriculum revision some inherent disadvantages had to be overcome. Past quarterly face-to-face meetings with the EET advisory committee suggested that traditional face-to-face methods of curriculum revision (e.g. DACUM) would not be useful. The underlying reason pointed towards group dynamics. Past group meetings displayed:

-an influence of dominant individuals,
-communication noise (individual and group interests instead of problem-solving), and
-group pressure for conformity.

Additional factors considered were the logistics of calling together all the committee members at convenient times. Past attendance at these called meetings was sparse and nothing indicated the trend would change. The *Delphi* technique seemed an ideal alternative to traditional approaches.

In a strict sense, the Delphi technique is one of four basic types of long-range forecasting that may be classified as an intuitive forecasting method through use of assembled panels of experts. The other forecasting types include trend extrapolation, which predicts future events based upon past events; trend correlation analysis, or the relation of a trend to two or more other trends; and, analogy, whereby an event is compared to

another event such as the growth of the population in comparison with the growth of yeast cells. An excellent review of these techniques can be found in Martino (1972).

The Delphi technique is implemented by first assembling a panel of experts for the particular problem. Each expert is then asked to make anonymous forecasts about the problem. At the end of this first session, or *round*, the responses are studied and each panelist then receives composite feedback of the way other panel members answered the questions, and a second round of forecasting begins. The entire process may be repeated many times. Panelists can change their minds since all responses are anonymous and face-to-face meetings forbidden, thereby removing the pressures of group dynamics.

The first published account of the Delphi method was by Dalkey and Helmer (1972) based upon experiments performed at the RAND Corporation. Delphi procedures were described by Dalkey and Helmer to have three basic features: (1) anonymity, (2) controlled feedback, and (3) statistical group response. Anonymity, by use of questionnaires or other formal communication channels, reduces the effect of dominant individuals. Controlled feedback reduces communication noise. The feedback consists of conducting the exercise in a sequence of *rounds* and providing a summary of results of the previous rounds to the participants until a consensus is formed. Reduction of group pressure for conformity is by use of a statistical definition of the group

response. While there may be wide variations at the end of the process of individual opinions, the statistical group response assures that the opinion of every participant is represented in the final response.

More common uses of the Delphi have been in the field of technological forecasting by use of panels of experts(Martino,1972). The use of the Delphi in educational settings has not been reported extensively in the literature. A literature search of curriculum development in technical education by the author revealed only one case study of curriculum revision using the Delphi process. In that report (Reeves and Jauch,1978) the Delphi process was used by the Business School's advisory committee for revision of a bachelor's degree program at Southern Illinois University. The limited participation rate of 14% in that study limits any useful conclusions. These researchers reported a similiar lack of published research in their study.

The lack of available research information cannot be attributed to educators being uninformed about Delphi. Judd (1972) reported

> at least five major uses of the Delphi have emerged in higher education: cost-effectiveness; cost-benefit analysis; curriculum and campus-planning; college, university-wide and state-wide educational goals and objectives; consensus on...generalized educational goals and objectives for the future. (p. 3)

Wetherman and Swenson (1974) also noted that

> There are a number of advantages to the use of the Delphi technique in educational planning when consultation is desired. It provides a means of obtaining information from a large number of persons without the restrictions often imposed by geography and scheduling. Delphi is especially appealing because of ease of administration and relatively low cost when compared to the expense of convening a similar group. It provides a means of obtaining information about particularly complex phenomena which are often difficult to conceptualize...Another merit is that the procedure is often looked upon by participants as an interesting and useful task. (pp. 111-112)

Judd (1972) also commented upon the lack of available published literature in his study of the state of Virginia university system. In that study he inserted a bogus response item on a questionnaire that later was shown to receive a low statistical response by participants.

It has been suggested that the success of educational reform will be judged by the willingness of administrators to abandon existing systems and make greater use of changed technology (Evans and McKeough,1981). Evans and McKeough noted the serious lack of use of the Delphi technique in educational settings, despite the obvious advantages of the method.

Successful vocational program criteria were identified by the Delphi method in a study of California vocational programs. In that study by Dagenais (1975), successful programs were found to have such characteristics as large visability on campus, state regulation through licenses, applicant screening for the program, and these programs did not offer remedial courses.

Most of the arguments for the utility of the Delphi process center about the use of a panel of experts. Dalkey (1969) reported the increased accuracy of responses having high

correlation to the participant's self-rating of expertise about the particular subject. The use of advisory committee members cannot be considered the use of experts in a traditional sense if we define "expert" as a thoroughly skilled practitioner.

While the use of so-called "non-experts" may give rise to the use of the title *Modified Delphi* for the curriculum revision process, the practice can be supported if the literature is consulted. Pill (1971) maintained that an "expert" was anyone capable of contributing relevant information. The inputs from engineering undergraduates produced essentially the same inputs as from advanced engineering scientists when forecasting values in a study by Welty (1971). Jolson and Rossow (1971) pointed out, however, that "knowledge of the subject area is necessary for the proper operation of the Delphi process." There is always the alternative of weighting the responses of the participants according to their self-rated "degree of expertise." An earlier reference to Dalkey (1969) and a study by Best (1974) support this approach.

METHOD

The pre-ABET report (personal communication in letter July 14, 1985) made it clear to the EET department that past efforts to revise the curriculum were insufficient. These methods usually consisted of faculty suggestions with little or no input from the advisory committee. The need for a major reduction of the current seven-quarter program to a six-quarter program was also addressed by the pre-ABET report. The Georgia Department of Education (GDOE) had imposed a December 1985 deadline for submission of recommendations that address the pre-ABET findings. The submitted recommendations were to include a proposed six-quarter EET sequence that meet the minimum standards of the Accreditation Board for Engineering and Technology.

Since technical relevancy of the curriculum was to be examined together with the need to reduce the curriculum to six-quarters then industry practitioners seemed the likely choices for input to the revision process. The EET advisory committee is fully composed of working professional engineers and technicians. The diversity of backgrounds, however, had hindered effective progress in past meetings of the advisory committee. The group dynamics of these face-to-face meetings usually prevented effective problem-solving and forced the EET faculty to make any final decisions. Additionally, the logistics of the meetings required several hours of phone calls, letters, and follow-up yet still resulted in poor attendance. The Delphi technique was chosen to alleviate these problems.

Wetherman and Swenson (1974) have noted the lack of geographical limitations on the Delphi technique. They have also commented upon the economy and ease of administration of the Delphi.

The Delphi's utility to curriculum planning had been stated by Judd (1972) and applied to a college business program by Reeves and Jauch (1978).

The Delphi's relative immunity to group dynamics had been shown by Rand Corporation studies conducted by Dalkey and Helmer (1972).

These facts, combined with the current heavy workloads of the EET department faculty, supported the choice of the Delphi technique over the traditional methods of curriculum planning that involve face-to-face meetings. The Delphi technique allowed maximum utilization of the advisory committee with the minimum amount of time to comply with imposed GDOE deadlines.

The basic instrument used for the Delphi rounds is shown in Appendix A. Courses and sub-course content areas were solicited from the appropriate academic departments. A Likert-type scale was chosen to measure participant responses to suggested subjects and their respective sub-content areas.

Originally, it was the author's intent to conduct the Delphi rounds using computer terminals. This approach has been suggested by Dalkey (1969) as an alternative to the mailed questionnaire. However, time deadlines imposed by the GDOE precluded such an approach due to lack of necessary funding for required equipment.

Instead the instrument was mailed by the author to all members of the EET advisory committee with a self-addressed,

stamped return envelope to encourage larger participation. A follow-up telephone call by the author within one week of the mailing also encouraged participation.

Participant anonymity had been pledged, but the return envelopes were coded according to participant backgrounds. On the return address of each envelope provided the Delphi participant one of the following codes appeared:

Technician	R
Former Student	G
Engineer	B
Educator	Y

The envelopes were coded in anticipation of future statistical analyses between participant classifications to identify significant ($p < .05$) trends. Two weeks were allowed for this first Delphi round.

The received information was compiled during the third week to provide feedback to the participants for the second Delphi round. The feedback included a list of comments made by the participants on the round one document (Appendix A) and the areas of participant agreement concerning courses and sub-content areas. Any inconsistencies or misunderstandings that had arisen were also corrected during this second round. A common problem noted was the absence of a ranking for some of the courses listed despite the fact that the sub-content areas of those courses were

ranked. Apparently the document design was flawed by placing the course rating blank to the right of the course title and not to the left to match the sub-content area blanks.

During the second Delphi round, beginning the fourth week, the participants were asked to reconsider their rankings in light of the supplied comments and agreement areas. The same document of Appendix A was used with the exception that all areas showing group agreement (>65%) were blocked from further rankings (see Appendix B). The participants were also asked to make comments to defend their particular rankings that deviated from the majority. This second mailing was also followed-up with telephone reminders by the author during the fifth week.

The sixth week was used to compile the second round results. At this time a strong indication of convergence of group opinion was noted and a third Delphi round was deemed unnecessary in light of Cyphert and Gant (1970). In that study it was noted that virtually all changes of opinion had occurred by the end of the second round in the presence of group convergence and that a third round yielded virtually no significant changes.

During the tenth week a face-to-face de-briefing of the Delphi participants was scheduled by the author. The results of the Delphi rounds were shared with those in attendance and the participants were asked to complete a final survey. The final survey shown in Appendix C solicited feedback concerning the usefulness of the Delphi method for curriculum revision .

RESULTS

The final recommended six-quarter curriculum based upon this practicum and submitted to the GDOE for consideration appears in Appendix D.

Participant responses were averaged and those courses receiving favorable rankings (3 or higher) were included in the final recommendations. Sub-content areas will be evaluated at a later date and therefore do not appear on the GDOE submitted recommendations. However, those courses currently being offered will be revised to reflect the emphasis indicated by participant rankings of sub-content areas.

Immediate results of the Delphi curriculum process included:

-The calculus I course was eliminated based upon participant recommendations (average ranking : 2.4).

-Industrial relations was selected as the social science elective (average ranking: 3.5).

-While it is not apparent from the document shown in Appendix D, several changes were made in the sub-content areas of some existing courses based upon participant comments while still meeting state imposed competency guidelines.

-A six-quarter program that meets ABET criteria has been suggested.

-A previously non-existing course, control systems theory, was strongly recommended (average ranking: 4.4).

-Several courses that were thought to be essential to the undergraduate have been identified as simply electives.

In addition to the expected results of this Delphi-based process there occurred not a few indirect results. Most surprising was the enthusiasm of the participants. Of the thirteen selected participants, eleven, or nearly 85%, responded to both Delphi rounds. This is a very high return rate for a questionnaire study where 20% return rates are considered the norm.

The after-study survey (see Appendix C) and direct questioning revealed that the participants felt that they were part of an important decision-making process (85%) and that their comments were seriously being considered (80%) by the faculty and administration. The participants also indicated that they felt more was accomplished using the Delphi technique than could have been with the usual face-to-face meetings (90%).

On the negative side, however, over 30% of the participants indicated a limited understanding of the Delphi process. This response suggests that more detailed explanations are required in the initial cover letter to participants.

The EET department's faculty were also forced to examine past teaching practices in light of the received comments from the Delphi participants. Several course content areas were revised to reflect modern trends indicated by the participants. These findings demonstrated the need for a close partnership between the educator and the industrial practitioner. This practicum renewed that partnership by involving both parties in the curriculum revision process.

RECOMMENDATIONS

The Delphi technique is ideally suited to the curriculum revision process yet the literature indicates it is rarely used in that capacity. This practicum has demonstrated the Delphi technique to be suitable when faced with time, funding, and geographical constraints. Further research is needed to compare, say, the results of this practicum with the results of a traditional face-to-face type curriculum revision process.

Participant background may play a part in the curriculum revision process. During this practicum the participants were coded according to background. A planned computer-assisted statistical analysis will explore the relationship between background and technical course rankings.

The reduction of a technical program so dramatically also hints that there exists some *generic* technical base of knowledge upon which other courses may build. Can this generic base be indentified? If identified, what are the implications to traditional technical education programs?

Finally, the literature is not clear concerning the use of so-called *non-experts* with the Delphi technique. A planned study using the participants self-ranked expertise in this practicum's subject area (see Appendix C, question 5) will seek answers to this dilemma.

The results of this practicum have been shared with several technical educators nationwide who participated in the process. A presentation before the American Society for Engineering Education is also being planned. Other academic departments have indicated strong interest in the use of the Delphi technique for curriculum revision.

There have also been inquiries by school administrators concerning the utility of the Delphi technique in the decision-making process.

The author has made himself available to anyone interested in the Delphi technique and is available to present further details to interested parties. The author may be contacted at 3607 Albemarle Court, Augusta, Georgia 30906.

References

Accreditation Board for Engineering and Technology. (1984). *1984 Annual Report*. New York: Author.

Best, R.J. (1974). An experiment in Delphi estimation in marketing decsision making.*Journal of Marketing Research, 11,* 448-452.

Brodsky, S.M. (1983, May). What accreditation reports reveal about the status of ET education.*Engineering Education,* pp.77-83.

Cyphert, F. & Gant, W. (1970). *The Delphi technique: A tool for collecting opinions in teacher education.* Paper presented at the annual meeting of the AERA, Minneapolis, MN.

Dagenais, F. (1975). *Characteristics of successful community college vocational education programs.*(Bureau No. 69443-C065-71). Sacramento, CA: State Dept. of Education. (ERIC Document Reproduction Service No. ED 149 827)

Dalkey, N.C. (1969). *The Delphi method: An experimental study of group reaction.*(RAND Memorandum RM-5888-PR). Santa Monica, CA: The RAND Corporation.

Dalkey, N.C. & Helmer, O. (1972). *Studies in the quality of life: Delphi and decisionmaking.* Santa Monica, CA: RAND Corporation.

Hass, G. (1980). Curriculum criteria. In G. Hass (Ed.),*Curriculum planning: A new approach* (pp. 217-224). Boston: Allyn and Bacon.

Jolson, M. A. & Rossow, G. L. (1971). The Delphi process in marketing decision making. *Journal of Marketing Research, 11,* 448-452.

Judd, R.C. (1972). Delphi decision methods in higher education administration. *Research in Education, 12,* 75.

Martino, J. P. (1972). *Technological forecasting for decisionmaking* (pp. 18-63). New York: American Elsevier.

Parry-Hill, J. W., Jr. (1981). *Highlights from two recent studies on the use of Citizen Advisory Groups in the North Carolina Community Colleges.* Rayleigh, NC: State Advisory Council on Education. (ERIC Document Reproduction Service No. ED 210 054)

Pill, J. (1971). The Delphi method: Substance, context, a critique and an annotated bibliography. *Socio-Economic PLanning Sciences, 5.*

Reeves, G. & Jauch, L. R. (1978). Curriculum development through Delphi.*Research in Higher Education, 8*,157-168.

Welty, G. (1971). *A critique of some long-range forecasting developments.* Paper presented at the 38th Session of the International Statistical Institute, Washington, D.C.

Wetherman, R. & Swenson, K. (1974). Delphi technique. In S.I. Hencley & J. R. Yates (Eds.), *Futurism in education: Methodologies* (pp. 111- 112). Berkley, CA: McCutcheon.

Bibliography

Bright, James R. (1968). *Technological forecasting for industry and government.* Englewood Cliffs: Prentice-Hall.

Dalkey, N. C. & Helmer, O. (1963). An experimental application of the Delphi method to the use of experts. *Management Science, 9.*

Evans, M. L. & McKeough, W. J. (1981). *A pro-active model for curriculum change.* Paper presented at the annual meeting of the Eastern Educational Research Association, Philadelphia, PA. (ERIC Document Reproduction Service No. ED 206 078)

Finch, C. R. & Crunkilton, J. R. (1979). *Review and critique of strategies for determining career education curriculum content.* Paper presented at the annual meeting of the AERA. (ERIC Document Reproduction Service No. ED 178 696)

Hopkins, Charles O. (1972). *Delphi: A Planning Tool.* Oklahoma State Department of Vocational and Technical Education. (ERIC Document Reproduction Service No. ED 065 689)

Linstone, H. A. & Turoff, M. (1975). *The Delphi method: techniques and applications.* Reading, MA: Addison-Wesley.

Martin, L. L. & Maynard, O. (1973). Private institutions of higher education: an application of the Delphi technique. *Intellect, 102,* 129 -131.

Martino, J. P. (1968). An experiment with the Delphi procedure for long-range forecasting. *IEEE Transactions on Engineering Management, EM-15,* 138-144.

Owens, B. D. (1968). Decision theory in academic administration. *Academy of Management Journal, 11,* 221 - 232.

Van de Ven, A. H. & Delbecq, A. L. (1974). The effectiveness of nominal Delphi, and interacting group decision making processes. *Academy of Management Journal, 17,* 604 - 621.

Welty, G. (1973). Some problems of selecting Delphi experts for educational planning and forecasting exercises. *California Journal of Educational Research, 24,* 129 - 134.

APPENDIX A

Round One Document & Cover Lettter

As you know, the Electronics Engineering Technology Department is seeking accredidation by the Accredidation Board for Engineering and Technology (ABET). A recent visit by some ABET members has suggested the need for major curriculum revisions. As a result of one of these recommendations the State has requested that all Engineering Technology schools propose a curriculum for a six-quarter program. We are seeking your assistance in this effort.

In order to afford you the maximum time for this vital process we are asking you to participate in a consensus technique known as Delphi. Basically, the Delphi method involves anonymous responses to submitted items that will be statistically analyzed. The results of this analysis will then be reported back to all participants to allow them the opportunity to revise any previous responses. AT NO TIME DO WE OR ANY OF THE PARTICPANTS KNOW THE IDENTITY OF THE RESPONDENT. The results of this second "round" will then be analyzed to determine the need for a final third "round".

Your participation and prompt response will be appreciated. The success of the EET program requires active participation by those in industry and education. We thank you for your continued support.

Sincerely,

Electronic Engineering Technology
Department

RESPONDENT INSTRUCTIONS

Enclosed are suggested courses to be included in a six-quarter electronic engineering technology degree program. Each course listed is further subdivided into content areas of that subject.

Next to each content area listed are blanks provided for your response to these items.

Your responses, which will consist of a range of numbers from 1 to 5, will be based upon your level of agreement with the courses and content areas of those courses. The content areas of the technical electives are not listed since we are primarily concerned with the required suggested courses at this time. At a later date we will fully develop these elective courses.

Let's take a look at an example of how you will rank your responses. Consider the listing below:

Floral Arranging I _5_

_4_ Structures
_2_ Color Schemes

You are being asked to place your level of agreement to the above course and its respective content areas according to the levels listed below:

STRONGLY AGREE = 5
HIGH AGREEMENT = 4
AGREE = 3
HIGH DISAGREEMENT = 2
STRONGLY DISAGREE = 1

For example, if you had strongly agreed with the course, Floral Arranging, you would have placed the number **5** in the space provided to the right of that course. If you had high agreement with the content area, Structures, of the course you would have placed the number **4** in the space next to that content area.

And, if you had high disagreement with the content area, Color Schemes, you would have placed the number **2** next to that content area.

Additional spaces will be provided for you to make suggestions concerning course content areas. Please feel free to place any other comments at the bottom of each paper.

IDENTIFYING MARK

In order to report to you concerning your responses in relation to the group's responses it will be necessary for some identifying mark to be placed at the bottom of each page attached. We suggest that you use a sequence of numbers from your Social Security number that you will remember and continue to use throughout the Delphi process. **Please place your identifying number at the bottom of each paper now.**

Since we are operating under strict time guidelines it is essential that we receive your responses within five working days after receipt. Someone from our office will be calling to remind each participant of these deadlines.

FIRST YEAR

CIRCUITS I _____

_____Electricity
_____Series Circuits
_____Parallel Circuits
_____DC Circuit Theorems
_____Capacitance & Inductance

_____

_____

Algebra _____

_____Fundamental Concepts in Technical Math
_____Functions & Graphs
_____Linear equations & Determinants
_____Factoring & Fractions
_____Quadratic Equations

_____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

English & Composition _____

_____Importance of effective communication skills to the technician
_____Diction/Standard, Formal Usage
_____Parts of Speech
_____Sentence structure
_____Sentence conciseness
_____Capitalization & Punctuation
_____Paragraph structure
_____Theme construction

_____

_____

Social Science Elective
Choose one from the following:

_____Economics
_____Industrial Psychology
_____Human Relations

_____

_____

ADDITIONAL COMMENTS:

ID#_____

FIRST YEAR

Circuits II _____

_____Magnetism
_____Inductance & Capacitance
_____Alternating Current
_____Reactance
_____Impedance

_____

_____

Computer Fundamentals _____

_____Intro. to the Microprocessor
_____Programming Concepts in BASIC
_____Branching & Looping
_____Arrays
_____Functions & Subroutines
_____Data Files
_____Engineering Analysis Applications
_____Graphics

_____

_____

Trigonometry _____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

_____Trig. functions of any angle
_____Vectors & Triangles
_____Graphs of trig. functions
_____Exponents & Radicals
_____The j-operator
_____Properties of trig. functions
_____Inverse trig. functions
_____Logarithms
_____Systems of equations

_____

_____

Physics I _____

_____Units & Measurement
_____Velocity & Acceleration
_____Newton's Laws
_____Work & Energy
_____Properties of Matter

_____

_____

ADDITIONAL COMMENTS:

ID#_____

FIRST YEAR

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Electronics I _____

_____Semiconductor Diodes
_____Zeners & two-terminal devices
_____Transistors
_____DC Biasing
_____FETs & Biasing
_____BJT small-signal analysis
_____FET small-signal analysis
_____Multistage systems
_____Large-signal amplifiers

_____

_____

Analytic Geometry & Calculus _____

_____Elements of Analytic Geometry
_____Sequences & Series
_____Derivatives
_____Integration
_____Transcendental Derivatives

_____

_____

Circuit Analysis _____

_____Complex Networks analysis
_____Resonance
_____Transformers

_____

_____

Physics II _____

_____Thermal properties of matter
_____Gas Laws
_____Basic Fluid Mechanics
_____1st & 2nd Laws of Thermodynamics
_____Vibratory motion
_____Wave motion
_____Sound
_____Resonance
_____Light, Interference & Diffraction
_____Particle Radiation

_____

_____

ADDITIONAL COMMENTS:

ID#_____

SECOND YEAR

Electronics II _____

_____PNPN and other devices
_____Integrated Circuits
_____Diff. Amps & Linear ICs
_____IC Regulators
_____Digital ICs
_____Linear Digital ICs
_____Feedback amps & Oscillators

_____

_____

Calculus I _____

_____Applied Derivatives
_____Higher Derivatives
_____Applied Integrals
_____Hyperbolic Functions
_____Partial Derivatives
_____Double Integrals
_____Fourier Series
_____Taylor Series
_____Maclaurin Series
_____Intro. Differential Eqs.

_____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Digital Electronics _____

_____Number Systems
_____Logic Families
_____Flip-Flops & Registers
_____Sequential Logic Circuits
_____Combinatorial logic
_____Memory circuits

_____

_____

Technical Writing _____

_____Conducting Technical Research
_____Planning the Technical Report
_____Formal Technical Writing
_____Presenting Oral Technical Reports
_____Describing Technical Processes
_____Describing Technical Mechanisms

_____

_____

ADDITIONAL COMMENTS:

ID#_____

SECOND YEAR

Microcomputer Applications I _____

_____Multiplication & BCD addition
_____Basic I/O & Interfacing
_____Programmable peripheral chips
_____Data communications
_____Controllers

_____

_____

Linear Integrated Circuits _____

_____Intro. Op-Amps
_____Inverting & Non-Inverting
_____Comparators
_____Bias, Offsets & Drift
_____Bandwidth, Slew rates & Frequency compensation
_____Active Filters
_____Signal Generators

_____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Technical Elective
Choose one from the following:

_____Anatomy & Physiology
_____Communication Systems
_____Antennas & Microwaves
_____Pulse & Waveshaping
_____Control Systems Theory

_____

_____

ADDITIONAL COMMENTS:

ID#_____

SECOND YEAR

Linear Circuit Applications _____

_____Power Amplifiers
_____Video Amplifiers
_____Modulators, Demod. & Phase detectors
_____VCOs
_____PLLs
_____Multipliers & Dividers
_____IC Transducers
_____D-to-A Converters
_____Analog switches & Sample & Hold circuits
_____CCDs
_____Special Function ICs
_____Optoelectronic ICs

_____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Technical Electives
Choose <u>two</u> from the following:

_____Biomedical Instrumentation
_____Biomedical Practicum
_____Digital Communications
_____Satellite & Telecommunications
_____EET Problems
_____Microcomputer Appl. II
_____Pulse & Waveshaping
_____Control Systems Theory
_____16-bit Microprocessors

_____

_____

ADDITIONAL COMMENTS:

ID#_____

FINAL SUMMARY

Using the following ranking scale, predict the importance of the courses listed below to the electronic engineering technician in the next five years.

Very Important = 5
Important = 4
No change = 3
Little Importance = 2
Not Important = 1

_____Linear Integrated Circuits
_____Digital Communications
_____Satellite Systems
_____Telecommunications
_____Pulse & Waveshaping
_____Control Systems Theory
_____Communication Systems
_____Computer Fundamentals
_____Technical Writing
_____
_____

Please place a check mark in the category below that best describes your current position:

_____Recent technical school graduate
_____Industry EET Technician
_____Industry Electrical Engineer
_____Engineering Technology Educator
_____

This concludes the study. Check that you have placed a sequence of numbers THAT YOU WILL REMEMBER at the bottom of each of these papers. We will be giving you feedback concerning your responses in relation to the responses of the group and your identifying numbers are the only means of accomplishing this process. All identifying numbers will be listed and you must pick your own number from that list in order to determine your statistical position with the group. At that time we will ask you to reconsider your responses and to again perform some sort of ranking. It is essential that we receive the completed papers within 7 days after you have received them. Again, we appreciate your cooperation and promptness.

ID#_____

APPENDIX B

Round Two Document & Cover Letter

RESPONDENT INSTRUCTIONS

Enclosed are the materials necessary for the second, and possibly the final, Delphi round. Your prompt and excellent responses have streamlined the process considerably. We will appreciate your continued efforts.

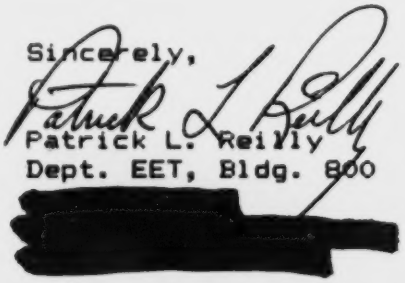
Basically, this round will follow the previously given instructions with a few minor exceptions. Please note that many of the subjects and content areas have been marked with an "X". You have indicated agreement with the other Delphi participants in these marked areas and no further ranking is required. PLEASE RANK ALL COURSES and CONTENT AREAS THAT HAVE NOT BEEN MARKED WITH AN "X". In other words, place your rank according to the scale listed next to ALL blank areas. Your responses have not agreed with the others participating for these unmarked courses and content areas. It is important that we have your opinion for these areas in order to make sound decisions. At the end of each page you will find your previously submitted comments during the first round. Please support your rankings with any additional comments you feel are necessary.

In addition to your normal ranking of courses and content areas we have placed a couple of questions on some pages for additional information-don't forget to answer these, too.

Finally, you must remember to place your identification number on each page. Use the same number that you used during round one. The numbers of those participating are listed below. If your number does not appear, we received your initial responses after the round one cutoff date. That does not mean, however, that your data has not been analyzed, or that you should not participate in round two. We need your input!

We are operating under heavy time restrictions and encourage you to reply promptly using the self-addressed stamped envelope enclosed. Should this indeed be the last round let me take a moment to express my appreciation for your efforts and extend to you an invitation to visit with me when in the Augusta area. I can be reached by calling (404) 796-6900 ext. 286, during normal school hours.

Sincerely,



Patrick L. Reilly
Dept. EET, Bldg. 800
[redacted]

ID NUMBERS:

133JAD 2144 54370 0370 1400 2637 11263 3030

4378 5519

FIRST YEAR

Please indicate below your answer to the question:

"What type of current flow should be used in the EET program?"

Conventional_____

Electron flow_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

CIRCUITS I X

X Electricity
X Series Circuits
X Parallel Circuits
X DC Circuit Theorems
_____Capacitance & Inductance

_____

_____

Algebra X

X Fundamental Concepts in Technical Math
X Functions & Graphs
X Linear equations & Determinants
X Factoring & Fractions
X Quadratic Equations

_____

_____

English & Composition X

X Importance of effective communication skills to the technician
_____Diction/Standard, Formal Usage
_____Parts of Speech
_____Sentence structure
_____Sentence conciseness
_____Capitalization & Punctuation
_____Paragraph structure
_____Theme construction

_____

_____

Social Science Elective
Choose from the following:

_____Economics
_____Industrial Psychology
_____Human Relations

_____

_____

ADDITIONAL COMMENTS: "Why not do AC circuits with DC?"
"Suggest English & Composition be two separate courses."
"Most of English & Composition content should have been covered in high school."

ID#_____

FIRST YEAR

Circuits II X

X Magnetism
X Inductance & Capacitance
_____ Alternating Current
_____ Reactance
_____ Impedance

Computer Fundamentals X

_____ Intro. to the Microprocessor
X Programming Concepts in BASIC
X Branching & Looping
X Arrays
_____ Functions & Subroutines
_____ Data Files
_____ Engineering Analysis Applications
_____ Graphics

Trigonometry X

X Trig. functions of any angle
X Vectors & Triangles
X Graphs of trig. functions
X Exponents & Radicals
_____ The j-operator
_____ Properties of trig. functions
_____ Inverse trig. functions
_____ Logarithms
_____ Systems of equations

Physics I X

X Units & Measurement
X Velocity & Acceleration
X Newton's Laws
X Work & Energy
X Properties of Matter

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

ADDITIONAL COMMENTS:

"Computer Fundamentals material cannot be properly covered in one term."
"Circuits II must use polar-rectangular notation and include power."
"Separate into. to the microprocessor from Computer Fundamentals."

ID#_____

FIRST YEAR

Electronics I X

- X Semiconductor Diodes
- X Zeners & two-terminal devices
- X Transistors
- ___ DC Biasing
- X FETs & Biasing
- X BJT small-signal analysis
- X FET small-signal analysis
- ___ Multistage systems
- ___ Large-signal amplifiers

Analytic Geometry & Calculus X

- ___ Elements of Analytic Geometry
- X Sequences & Series
- X Derivatives
- X Integration
- ___ Transcendental Derivatives

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Circuit Analysis ___

- ___ Complex Networks analysis
- ___ Resonance
- ___ Transformers

Physics II X

- X Thermal properties of matter
- X Gas Laws
- X Basic Fluid Mechanics
- ___ 1st & 2nd Laws of Thermodynamics
- X Vibratory motion
- X Wave motion
- X Sound
- X Resonance
- ___ Light, Interference & Diffraction
- ___ Particle Radiation

ADDITIONAL COMMENTS: "Circuit Analysis should be in Circuits II."
"Electronic I should be 2 courses or 6 hrs week for 14-15 wks."
"Applied calculus for Analytic Geo. & Calc. with no proofs."
"Include power factor in AC analysis."

ID#_____

SECOND YEAR

Electronics II X

_____PNPN and other devices
_____Integrated Circuits
_____Diff. Amps & Linear ICs
_____IC Regulators
_____Digital ICs
_____Linear Digital ICs
_____Feedback amps & Oscillators

_____

_____

Calculus I _____

_____Applied Derivatives
_____Higher Derivatives
_____Applied Integrals
_____Hyperbolic Functions
_____Partial Derivatives
_____Double Integrals
_____Fourier Series
_____Taylor Series
_____Maclaurin Series
_____Intro. Differential Eqs.

_____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Digital Electronics X

X Number Systems
X Logic Families
X Flip-Flops & Registers
X Sequential Logic Circuits
X Combinatorial logic
X Memory circuits

_____

_____

Technical Writing X

X Conducting Technical Research
X Planning the Technical Report
X Formal Technical Writing
X Presenting Oral Technical Reports
_____Describing Technical Processes
_____Describing Technical Mechanisms

_____

_____

ADDITIONAL COMMENTS: "ElectronicsII too diffused & heavy. Some content belongs in Linear IC course."
"Calculus I some content not appropriate."
"Tech writing should include job search processes."

ID#_____

SECOND YEAR

Please list below the types of computers you are using in your field or classroom:

_____

_____

Microcomputer Applications I X

_____Multiplication & BCD addition
_X_Basic I/O & Interfacing
_X_Programmable peripheral chips
_____Data communications
_____Controllers

_____

_____

Linear Integrated Circuits X

_X_Intro. Op-Amps
_X_Inverting & Non-Inverting
_X_Comparators
_____Bias, Offsets & Drift
_____Bandwidth, Slew rates & Frequency compensation
_____Active Filters
_____Signal Generators

_____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Technical Elective
Choose from the following:

_____Anatomy & Physiology
_____Communication Systems
_____Antennas & Microwaves
_____Pulse & Waveshaping
_____Control Systems Theory

_____

_____

ADDITIONAL COMMENTS: "Micro course may belong in reg. engineering course, not in technology."
"Add modems, printers, and disc drives to Micro I."

ID#_____

SECOND YEAR

Linear Circuit Applications X

_____Power Amplifiers
_____Video Amplifiers
__X__Modulators, Demod. & Phase detectors
__X__VCOs
__X__PLLs
__X__Multipliers & Dividers
_____IC Transducers
__X__D-to-A Converters
__X__Analog switches & Sample & Hold circuits
_____CCDs
_____Special Function ICs
_____Optoelectronic ICs

_ _____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Technical Electives
Choose from the following:

_____Biomedical Instrumentation
_____Biomedical Practicum
_____Digital Communications
_____Satellite & Telecommunications
_____EET Problems
_____Microcomputer Appl. II
_____Pulse & Waveshaping
_____Control Systems Theory
_____16-bit Microprocessors

_____

_____

ADDITIONAL COMMENTS:"Cannot cover all material shown in Linear Circuits course."

ID#_____

APPENDIX C

DELPHI PARTICIPANT FINAL SURVEY

Place a check mark beside the response that best describes your answer to the following:

1. I felt that this procedure was _____ useful.

   ____not ____somewhat ____very

2. I have a good understanding of what the procedure was all about.

   ____no ____somewhat ____average ____very much

3. I feel as though my suggestions were seriously considered along with those of the other participants:

   ____no ____somewhat ____average _____very much

4. I believe that I accomplished more by this method than I would have during face-to-face meetings.

   ____no ____somewhat _____average ____very much

5. Which below best describes your level of expertise about the subject of this Delphi exercise?

   _____none ____some ____average ____very much

Please indicate any personal comments below:

APPENDIX D

Proposed Curriculum

ELECTRONICS ENGINEERING TECHNOLOGY

FIRST QUARTER	Class	Lab	Contact hrs.	Credit hrs.
English and Composition	5	0	5	5
Algebra	5	0	5	5
D.C. Circuits	4	3	7	5
Computer Fundamentals	4	3	7	5
SECOND QUARTER				
Trigonometry	5	0	5	5
Engineering Graphics	1	6	7	3
Physics I	4	3	7	5
A.C. Circuits	4	3	7	5
THIRD QUARTER				
Analytic Geometry and Calculus	5	0	5	5
Physics II	4	3	7	5
Circuit Analysis	3	3	6	4
Electronics I (Semiconductor Analysis)	3	3	6	4
FOURTH QUARTER				
Technical Communications	5	0	5	5
Electronics II (Electronic Devices)	3	3	6	4
Digital Electronics	3	6	9	4
Elective*				
FIFTH QUARTER				
Microcomputer Applications I	4	3	7	5
Linear Integrated Circuits	4	3	7	5
Elective*				
Elective*				
SIXTH QUARTER				
Industrial Relations	5	0	5	5
Linear Applications	3	3	6	4
Elective*				
Elective*				

* Electives listed on separate page

ELECTIVES, Electronics

	Class	Lab	Contact hrs.	Credit hrs.
Anatomy and Physiology	3	3	6	4
Biomedical Instrumentation I	3	3	6	4
Biomedical Practicum	0	9	9	3
Antennas, Transmission Lines and Microwaves	3	3	6	4
Control System Theory	4	3	7	5
Pulse and Wave Shaping	3	3	6	4
Digital Communications	4	3	7	5
Satellite and Telecommunications	4	3	7	5
Microcomputer Applications II	4	3	7	5
16-Bit Microprocessors	4	3	7	5
Problems and Projects	0	9	9	3
Biomedical Instrumentation II	3	3	6	3
Communications Systems	4	3	7	5
Problems and Projects	1	12	13	5

CURRICULUM REVISION USING ADVISORY COMMITTEES AND A MODIFICATION OF THE DELPHI TECHNIQUE FOR ELECTRONIC ENGINEERING TECHNOLOGY PROGRAMS

by

PATRICK L. REILLY

A Practicum Report
submitted to the Faculty of the Center for the Advancement of Education of Nova University in partial fulfillment of the requirements for the degree of Master of Science.

April/1986

PURPOSE

The State of Georgia is seeking accreditation of six pilot postsecondary vocational-technical schools by the Accreditation Board of Engineering Technology (ABET), a private body consisting of professional engineering societies. These six schools offer a seven-quarter Associate of Science degree under a special provision of the State Board of Education in the areas of Electronic Engineering Technology (EET), Electromechanical Engineering Technology (EMT) and Mechanical Engineering Technology (MET). Part of the provision granting authorization to award a degree includes a requirement that the pilot schools actively seek and receive ABET accreditation within a given time frame or lose that authorization.

This practicum was set in one of these pilot institutions with an enrollment of over 2500 in all programs, including vocational and degree areas. Specifically, the degreed areas are referred to as the "high technology" or "hi-tech" programs and will be so called in this practicum. The hi-tech programs enroll approximately 200 students of which 85 are enrolled as electronic engineering technology (EET) majors. The author teaches in the EET program and is one of four faculty members in the EET Department.

Following almost three years of preparation on a state-wide scale, the hi-tech pilot schools contracted with ABET for a mock pre-ABET inspection of their programs as a prelude to an actual ABET visit to identify strengths and weaknesses. This school was visited by a four-member team from ABET and two Georgia Department of Education (GDOE) observers during the summer of

BEST COPY AVAILABLE

1985. During the visit, team-members inspected typical student work, texts, curricula, facilities and conducted interviews of faculty, and staff.

The pre-ABET team's written report (personal communication by letter July 14, 1985) was forwarded to this school detailing their recommendations and findings.

The pre-ABET team recommended that none of the hi-tech programs seek official accreditation until several deficiencies were eliminated. Specific to the EET program were the following:

-the physics sequence is a unified concepts based program that may limit transferability of credits to four-year institutions.

-instruction in the written communication skills is weak and needs substantial strengthening.

-an excessive number of hours are being allocated to computer fundamentals compared to other technical courses.

-the curricula are too long and the number of hours a student spends in class is excessive. The program content must be reduced to provide the student with a generalized technical background. A six-quarter sequence for the EET program was recommended by the pre-ABET inspection team.

The ABET-team report also made it clear that the present EET program was ambitious in content but lacked a stronger emphasis upon the "basics" of engineering technology. Instead of the concentration upon many of the so-called 'glamour' subjects of electronics, such as *digital communications, telecommunications,*

etc.. there should be a stronger emphasis placed upon the more generic subjects of electronics. The subjects would be those that every engineering technician is expected to know at a minimum level of competency.

The problem facing the EET department was identification of those courses that would meet the minimum requirements of competency. ABET(1984) has specified certain categorical requirements for a two-year EET degree program:

-program must be a minimum of 96 quarter hours.

-technical courses will be a minimum of 48 quarter hours.

-basic sciences and mathematics, including introductory calculus, will be a minimum of 24 quarter hours.

-social sciences/humanities will be a minimum of 13 quarter hours with at least 9 quarter hours of communications.

-the remainder of the courses should round out the EET program and meet the needs of the engineering technician for satisfactory industrial performance. It is left to the institution to address these additional needs.

Brodsky (1983) noted that nationwide accreditation visits by ABET resulted in citations for lack of a particular course or subject in 39% of the institutions visited with a two-year technical program and in 51% of the four-year technical programs. That same report noted that 7% of the two-year institutions operated at excessive vocational levels and 5% needed program curriculum review.

The formal application for ABET accreditation has been withdrawn by the EET department until the deficiencies listed in the pre-ABET report have been addressed satisfactorily. Since the

RESEARCH

This practicum used a forecasting consensus technique as a vehicle for curriculum revision. The technique has come to be known as *Delphi*, after the mythological Greek oracle. A review of the limited published literature suggested a utility for curriculum revision through use of the Delphi.

Hass (1980) has described a dynamical and self-renewing image of the curriculum revision process that consisted of four steps:

(1) Identification of the context in which curriculum implementation will occur. Context identification will entail data collection about learners and the various sociological variables with which the learners interact.

(2) Setting goals or determining objectives. Based upon the data collected in the first item, specific objectives for the intended learner are developed to co-exist with more generalized curriculum objectives.

(3) Selecting, preparing, and implementing strategies to achieve the curriculum changes intended as defined by the goals. Identification of available strategies and their selection is to be based upon the objectives and can be identified from the four bases of any curriculum,i.e., social forces, human development, learning natures, and knowledge/cognition.

(4) Evaluation. What has been accomplished in terms of the goals and objectives must be evaluated to provide information regarding learner achievement and performance. The evaluation will also yield information that will provide the basis for

reexamination of the curriculum, objectives, goals, and intended learner. There will be more evaluation following these revisions.

The EET Department is currently at the fourth step of this dynamical process and sought additional inputs from its advisory committee. Past self-reliance upon faculty member inputs alone has been called into question by the pre-ABET report (personal communication by letter July 14, 1985). Faculty inability to predict the usefulness of proposed curriculum changes due to technological outdatedness had been noted by the pre-ABET team members, therefore the advisory committee's constant exposure to changing technologies was seen to be an ideal characteristic necessary for suggested curriculum changes.

The use of advisory committees in the curriculum revision process is appropriate and also closely examined by ABET. In the 1983 report cited earlier by Brodsky, 15% of the two-year institutions studied and 31% of the four-year institutions were judged to have inadequate industrial advisory committees. It is interesting to note that the majority of the sixteen items detailing the major functions of advisory committees compiled by a study of North Carolina advisory groups and reported by Parry-Hill (1981) were concerned with curriculum processes:

(1) Offer advice on course and program development;
(2) Recommend course and program revisions to keep the curriculum relevant;
(3) Recommend equipment for use in programs;
(4) Assist in the formulation of goals and objectives in programs;
(5) Encourage local public support of programs;
(6) Assist in the evaluation of programs;
(7) Assist graduates in securing employment;
(8) Assist in student recruitment;
(9) Assist in long range program planning;
(10) Advise on facility construction and/or renovation;
(11) Assist in faculty recruitment;

BEST COPY AVAILABLE

another event such as the growth of the population in comparison with the growth of yeast cells. An excellent review of these techniques can be found in Martino (1972).

The Delphi technique is implemented by first assembling a panel of experts for the particular problem. Each expert is then asked to make anonymous forecasts about the problem. At the end of this first session, or *round*, the responses are studied and each panelist then receives composite feedback of the way other panel members answered the questions, and a second round of forecasting begins. The entire process may be repeated many times. Panelists can change their minds since all responses are anonymous and face-to-face meetings forbidden, thereby removing the pressures of group dynamics.

The first published account of the Delphi method was by Dalkey and Helmer (1972) based upon experiments performed at the RAND Corporation. Delphi procedures were described by Dalkey and Helmer to have three basic features: (1) anonymity, (2) controlled feedback, and (3) statistical group response. Anonymity, by use of questionnaires or other formal communication channels, reduces the effect of dominant individuals. Controlled feedback reduces communication noise. The feedback consists of conducting the exercise in a sequence of *rounds* and providing a summary of results of the previous rounds to the participants until a consensus is formed. Reduction of group pressure for conformity is by use of a statistical definition of the group

Wetherman and Swenson (1974) also noted that

> There are a number of advantages to the use of the Delphi technique in educational planning when consultation is desired. It provides a means of obtaining information from a large number of persons without the restrictions often imposed by geography and scheduling. Delphi is especially appealing because of ease of administration and relatively low cost when compared to the expense of convening a similar group. It provides a means of obtaining information about particularly complex phenomena which are often difficult to conceptualize...Another merit is that the procedure is often looked upon by participants as an interesting and useful task. (pp. 111-112)

Judd (1972) also commented upon the lack of available published literature in his study of the state of Virginia university system. In that study he inserted a bogus response item on a questionnaire that later was shown to receive a low statistical response by participants.

It has been suggested that the success of educational reform will be judged by the willingness of administrators to abandon existing systems and make greater use of changed technology (Evans and McKeough, 1981). Evans and McKeough noted the serious lack of use of the Delphi technique in educational settings, despite the obvious advantages of the method.

Successful vocational program criteria were identified by the Delphi method in a study of California vocational programs. In that study by Dagenais (1975), successful programs were found to have such characteristics as large visability on campus, state regulation through licenses, applicant screening for the program, and these programs did not offer remedial courses.

Most of the arguments for the utility of the Delphi process center about the use of a panel of experts. Dalkey (1969) reported the increased accuracy of responses having high

correlation to the participant's self-rating of expertise about the particular subject. The use of advisory committee members cannot be considered the use of experts in a traditional sense if we define "expert" as a thoroughly skilled practitioner.

While the use of so-called "non-experts" may give rise to the use of the title *Modified Delphi* for the curriculum revision process, the practice can be supported if the literature is consulted. Pill (1971) maintained that an "expert" was anyone capable of contributing relevant information. The inputs from engineering undergraduates produced essentially the same inputs as from advanced engineering scientists when forecasting values in a study by Welty (1971). Jolson and Rossow (1971) pointed out, however, that "knowledge of the subject area is necessary for the proper operation of the Delphi process." There is always the alternative of weighting the responses of the participants according to their self-rated "degree of expertise." An earlier reference to Dalkey (1969) and a study by Best (1974) support this approach.

stamped return envelope to encourage larger participation. A follow-up telephone call by the author within one week of the mailing also encouraged participation.

Participant anonymity had been pledged, but the return envelopes were coded according to participant backgrounds. On the return address of each envelope provided the Delphi participant one of the following codes appeared:

Technician	R
Former Student	G
Engineer	B
Educator	Y

The envelopes were coded in anticipation of future statistical analyses between participant classifications to identify significant ($p < .05$) trends. Two weeks were allowed for this first Delphi round.

The received information was compiled during the third week to provide feedback to the participants for the second Delphi round. The feedback included a list of comments made by the participants on the round one document (Appendix A) and the areas of participant agreement concerning courses and sub-content areas. Any inconsistencies or misunderstandings that had arisen were also corrected during this second round. A common problem noted was the absence of a ranking for some of the courses listed despite the fact that the sub-content areas of those courses were

ranked. Apparently the document design was flawed by placing the course rating blank to the right of the course title and not to the left to match the sub-content area blanks.

During the second Delphi round, beginning the fourth week, the participants were asked to reconsider their rankings in light of the supplied comments and agreement areas. The same document of Appendix A was used with the exception that all areas showing group agreement (>65%) were blocked from further rankings (see Appendix B). The participants were also asked to make comments to defend their particular rankings that deviated from the majority. This second mailing was also followed-up with telephone reminders by the author during the fifth week.

The sixth week was used to compile the second round results. At this time a strong indication of convergence of group opinion was noted and a third Delphi round was deemed unnecessary in light of Cyphert and Gant (1970). In that study it was noted that virtually all changes of opinion had occurred by the end of the second round in the presence of group convergence and that a third round yielded virtually no significant changes.

During the tenth week a face-to-face de-briefing of the Delphi participants was scheduled by the author. The results of the Delphi rounds were shared with those in attendance and the participants were asked to complete a final survey. The final survey shown in Appendix C solicited feedback concerning the usefulness of the Delphi method for curriculum revision .

BEST COPY AVAILABLE

RESULTS

The final recommended six-quarter curriculum based upon this practicum and submitted to the GDOE for consideration appears in Appendix D.

Participant responses were averaged and those courses receiving favorable rankings (3 or higher) were included in the final recommendations. Sub-content areas will be evaluated at a later date and therefore do not appear on the GDOE submitted recommendations. However, those courses currently being offered will be revised to reflect the emphasis indicated by participant rankings of sub-content areas.

Immediate results of the Delphi curriculum process included:

-The calculus I course was eliminated based upon participant recommendations (average ranking : 2.4).

-Industrial relations was selected as the social science elective (average ranking: 3.5).

-While it is not apparent from the document shown in Appendix D, several changes were made in the sub-content areas of some existing courses based upon participant comments while still meeting state imposed competency guidelines.

-A six-quarter program that meets ABET criteria has been suggested.

-A previously non-existing course, control systems theory, was strongly recommended (average ranking: 4.4).

-Several courses that were thought to be essential to the undergraduate have been identified as simply electives.

RECOMMENDATIONS

The Delphi technique is ideally suited to the curriculum revision process yet the literature indicates it is rarely used in that capacity. This practicum has demonstrated the Delphi technique to be suitable when faced with time, funding, and geographical constraints. Further research is needed to compare, say, the results of this practicum with the results of a traditional face-to-face type curriculum revision process.

Participant background may play a part in the curriculum revision process. During this practicum the participants were coded according to background. A planned computer-assisted statistical analysis will explore the relationship between background and technical course rankings.

The reduction of a technical program so dramatically also hints that there exists some *generic* technical base of knowledge upon which other courses may build. Can this generic base be indentified? If identified, what are the implications to traditional technical education programs?

Finally, the literature is not clear concerning the use of so-called *non-experts* with the Delphi technique. A planned study using the participants self-ranked expertise in this practicum's subject area (see Appendix C, question 5) will seek answers to this dilemma.

BEST COPY AVAILABLE

The results of this practicum have been shared with several technical educators nationwide who participated in the process. A presentation before the American Society for Engineering Education is also being planned. Other academic departments have indicated strong interest in the use of the Delphi technique for curriculum revision.

There have also been inquiries by school administrators concerning the utility of the Delphi technique in the decision-making process.

The author has made himself available to anyone interested in the Delphi technique and is available to present further details to interested parties. The author may be contacted at 3607 Albemarle Court, Augusta, Georgia 30906.

References

Accreditation Board for Engineering and Technology. (1984). *1984 Annual Report*. New York: Author.

Best, R.J. (1974). An experiment in Delphi estimation in marketing decsision making.*Journal of Marketing Research, 11,* 448-452.

Brodsky, S.M. (1983, May). What accreditation reports reveal about the status of ET education.*Engineering Education,* pp.77-83.

Cyphert, F. & Gant, W. (1970). *The Delphi technique: A tool for collecting opinions in teacher education.* Paper presented at the annual meeting of the AERA, Minneapolis, MN.

Dagenais, F. (1975). *Characteristics of successful community college vocational education programs.*(Bureau No. 69443-C065-71). Sacramento, CA: State Dept. of Education.
(ERIC Document Reproduction Service No. ED 149 827)

Dalkey, N.C. (1969). *The Delphi method: An experimental study of group reaction.*(RAND Memorandum RM-5888-PR). Santa Monica, CA: The RAND Corporation.

Dalkey, N.C. & Helmer, O. (1972). *Studies in the quality of life: Delphi and decisionmaking.* Santa Monica, CA: RAND Corporation.

Hass, G. (1980). Curriculum criteria. In G. Hass (Ed.),*Curriculum planning: A new approach* (pp. 217-224). Boston: Allyn and Bacon.

Jolson, M. A. & Rossow, G. L. (1971). The Delphi process in marketing decision making. *Journal of Marketing Research, 11,* 448-452.

Judd, R.C. (1972). Delphi decision methods in higher education administration. *Research in Education, 12,* 75.

Martino, J. P. (1972). *Technological forecasting for decisionmaking* (pp. 18-63). New York: American Elsevier.

Parry-Hill, J. W., Jr. (1981). *Highlights from two recent studies on the use of Citizen Advisory Groups in the North Carolina Community Colleges.* Rayleigh, NC: State Advisory Council on Education.
(ERIC Document Reproduction Service No. ED 210 054)

BEST COPY AVAILABLE

Pill, J. (1971). The Delphi method: Substance, context, a critique and an annotated bibliography. *Socio-Economic Planning Sciences, 5.*

Reeves, G. & Jauch, L. R. (1978). Curriculum development through Delphi.*Research in Higher Education, 8*,157-168.

Welty, G. (1971). *A critique of some long-range forecasting developments.* Paper presented at the 38th Session of the International Statistical Institute, Washington, D.C.

Wetherman, R. & Swenson, K. (1974). Delphi technique. In S.I. Hencley & J. R. Yates (Eds.), *Futurism in education: Methodologies* (pp. 111- 112). Berkley, CA: McCutcheon.

Bibliography

Bright, James R. (1968). *Technological forecasting for industry and government.* Englewood Cliffs: Prentice-Hall.

Dalkey, N. C. & Helmer, O. (1963). An experimental application of the Delphi method to the use of experts. *Management Science, 9.*

Evans, M. L. & McKeough, W. J. (1981). *A pro-active model for curriculum change.* Paper presented at the annual meeting of the Eastern Educational Research Association, Philadelphia, PA. (ERIC Document Reproduction Service No. ED 206 078)

Finch, C. R. & Crunkilton, J. R. (1979). *Review and critique of strategies for determining career education curriculum content.* Paper presented at the annual meeting of the AERA. (ERIC Document Reproduction Service No. ED 178 696)

Hopkins, Charles O. (1972). *Delphi: A Planning Tool.* Oklahoma State Department of Vocational and Technical Education. (ERIC Document Reproduction Service No. ED 065 689)

Linstone, H. A. & Turoff, M. (1975). *The Delphi method: techniques and applications.* Reading, MA: Addison-Wesley.

Martin, L. L. & Maynard, O. (1973). Private institutions of higher education: an application of the Delphi technique. *Intellect, 102,* 129 -131.

Martino, J. P. (1968). An experiment with the Delphi procedure for long-range forecasting. *IEEE Transactions on Engineering Management, EM-15,* 138-144.

Owens, B. D. (1968). Decision theory in academic administration. *Academy of Management Journal, 11,* 221 - 232.

Van de Ven, A. H. & Delbecq, A. L. (1974). The effectiveness of nominal Delphi, and interacting group decision making processes. *Academy of Management Journal, 17,* 604 - 621.

Welty, G. (1973). Some problems of selecting Delphi experts for educational planning and forecasting exercises. *California Journal of Educational Research, 24,* 129 - 134.

APPENDIX A

Round One Document & Cover Lettter

As you know, the Electronics Engineering Technology Department is seeking accredidation by the Accredidation Board for Engineering and Technology (ABET). A recent visit by some ABET members has suggested the need for major curriculum revisions. As a result of one of these recommendations the State has requested that all Engineering Technology schools propose a curriculum for a six-quarter program. We are seeking your assistance in this effort.

In order to afford you the maximum time for this vital process we are asking you to participate in a consensus technique known as Delphi. Basically, the Delphi method involves anonymous responses to submitted items that will be statistically analyzed. The results of this analysis will then be reported back to all participants to allow them the opportunity to revise any previous responses. AT NO TIME DO WE OR ANY OF THE PARTICPANTS KNOW THE IDENTITY OF THE RESPONDENT. The results of this second "round" will then be analyzed to determine the need for a final third "round".

Your participation and prompt response will be appreciated. The success of the EET program requires active participation by those in industry and education. We thank you for your continued support.

Sincerely,

Electronic Engineering Technology
Department

RESPONDENT INSTRUCTIONS

Enclosed are suggested courses to be included in a six-quarter electronic engineering technology degree program. Each course listed is further subdivided into content areas of that subject.

Next to each content area listed are blanks provided for your response to these items.

Your responses, which will consist of a range of numbers from 1 to 5, will be based upon your level of agreement with the courses and content areas of those courses. The content areas of the technical electives are not listed since we are primarily concerned with the required suggested courses at this time. At a later date we will fully develop these elective courses.

Let's take a look at an example of how you will rank your responses. Consider the listing below:

Floral Arranging I ___5___

__4__ Structures
__2__ Color Schemes

You are being asked to place your level of agreement to the above course and its respective content areas according to the levels listed below:

STRONGLY AGREE = 5
HIGH AGREEMENT = 4
AGREE = 3
HIGH DISAGREEMENT = 2
STRONGLY DISAGREE = 1

For example, if you had strongly agreed with the course, Floral Arranging, you would have placed the number **5** in the space provided to the right of that course. If you had high agreement with the content area, Structures, of the course you would have placed the number **4** in the space next to that content area.

And, if you had high disagreement with the content area, Color Schemes, you would have placed the number **2** next to that content area.

Additional spaces will be provided for you to make suggestions concerning course content areas. Please feel free to place any other comments at the bottom of each paper.

IDENTIFYING MARK

In order to report to you concerning your responses in relation to the group's responses it will be necessary for some identifying mark to be placed at the bottom of each page attached. We suggest that you use a sequence of numbers from your Social Security number that you will remember and continue to use throughout the Delphi process. **Please place your identifying number at the bottom of each paper now.**

Since we are operating under strict time guidelines it is essential that we receive your responses within five working days after receipt. Someone from our office will be calling to remind each participant of these deadlines.

FIRST YEAR

CIRCUITS I _____

_____Electricity
_____Series Circuits
_____Parallel Circuits
_____DC Circuit Theorems
_____Capacitance & Inductance

_____

_____

Algebra _____

_____Fundamental Concepts in Technical Math
_____Functions & Graphs
_____Linear equations & Determinants
_____Factoring & Fractions
_____Quadratic Equations

_____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

English & Composition _____

_____Importance of effective communication skills to the technician
_____Diction/Standard, Formal Usage
_____Parts of Speech
_____Sentence structure
_____Sentence conciseness
_____Capitalization & Punctuation
_____Paragraph structure
_____Theme construction

_____

_____

Social Science Elective
Choose <u>one</u> from the following:

_____Economics
_____Industrial Psychology
_____Human Relations

_____

_____

ADDITIONAL COMMENTS:

ID#_____

FIRST YEAR

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Circuits II _____

_____Magnetism
_____Inductance & Capacitance
_____Alternating Current
_____Reactance
_____Impedance

_____

_____

Computer Fundamentals _____

_____Intro. to the Microprocessor
_____Programming Concepts in BASIC
_____Branching & Looping
_____Arrays
_____Functions & Subroutines
_____Data Files
_____Engineering Analysis Applications
_____Graphics

_____

_____

Trigonometry _____

_____Trig. functions of any angle
_____Vectors & Triangles
_____Graphs of trig. functions
_____Exponents & Radicals
_____The j-operator
_____Properties of trig. functions
_____Inverse trig. functions
_____Logarithms
_____Systems of equations

_____

_____

Physics I _____

_____Units & Measurement
_____Velocity & Acceleration
_____Newton's Laws
_____Work & Energy
_____Properties of Matter

_____

_____

ADDITIONAL COMMENTS:

ID#_____

FIRST YEAR

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Electronics I _____

_____Semiconductor Diodes
_____Zeners & two-terminal devices
_____Transistors
_____DC Biasing
_____FETs & Biasing
_____BJT small-signal analysis
_____FET small-signal analysis
_____Multistage systems
_____Large-signal amplifiers

_____

_____

Analytic Geometry & Calculus _____

_____Elements of Analytic Geometry
_____Sequences & Series
_____Derivatives
_____Integration
_____Transcendental Derivatives

_____

_____

Circuit Analysis _____

_____Complex Networks analysis
_____Resonance
_____Transformers

_____

_____

Physics II _____

_____Thermal properties of matter
_____Gas Laws
_____Basic Fluid Mechanics
_____1st & 2nd Laws of Thermodynamics
_____Vibratory motion
_____Wave motion
_____Sound
_____Resonance
_____Light, Interference & Diffraction
_____Particle Radiation

_____

_____

ADDITIONAL COMMENTS:

ID#_____

SECOND YEAR

Electronics II _____

_____PNPN and other devices
_____Integrated Circuits
_____Diff. Amps & Linear ICs
_____IC Regulators
_____Digital ICs
_____Linear Digital ICs
_____Feedback amps & Oscillators

_____

_____

Calculus I _____

_____Applied Derivatives
_____Higher Derivatives
_____Applied Integrals
_____Hyperbolic Functions
_____Partial Derivatives
_____Double Integrals
_____Fourier Series
_____Taylor Series
_____Maclaurin Series
_____Intro. Differential Eqs.

_____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Digital Electronics _____

_____Number Systems
_____Logic Families
_____Flip-Flops & Registers
_____Sequential Logic Circuits
_____Combinatorial logic
_____Memory circuits

_____

_____

Technical Writing _____

_____Conducting Technical Research
_____Planning the Technical Report
_____Formal Technical Writing
_____Presenting Oral Technical Reports
_____Describing Technical Processes
_____Describing Technical Mechanisms

_____

_____

ADDITIONAL COMMENTS:

ID#_____

SECOND YEAR

Microcomputer Applications I _____

_____Multiplication & BCD addition
_____Basic I/O & Interfacing
_____Programmable peripheral chips
_____Data communications
_____Controllers

_____

_____

Linear Integrated Circuits _____

_____Intro. Op-Amps
_____Inverting & Non-Inverting
_____Comparators
_____Bias, Offsets & Drift
_____Bandwidth, Slew rates & Frequency compensation
_____Active Filters
_____Signal Generators

_____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Technical Elective
Choose <u>one</u> from the following:

_____Anatomy & Physiology
_____Communication Systems
_____Antennas & Microwaves
_____Pulse & Waveshaping
_____Control Systems Theory

_____

_____

ADDITIONAL COMMENTS:

ID#_____

SECOND YEAR

Linear Circuit Applications _____

_____Power Amplifiers
_____Video Amplifiers
_____Modulators, Demod. & Phase detectors
_____VCOs
_____PLLs
_____Multipliers & Dividers
_____IC Transducers
_____D-to-A Converters
_____Analog switches & Sample & Hold circuits
_____CCDs
_____Special Function ICs
_____Optoelectronic ICs

_____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Technical Electives
Choose <u>two</u> from the following:

_____Biomedical Instrumentation
_____Biomedical Practicum
_____Digital Communications
_____Satellite & Telecommunications
_____EET Problems
_____Microcomputer Appl. II
_____Pulse & Waveshaping
_____Control Systems Theory
_____16-bit Microprocessors

_____

_____

ADDITIONAL COMMENTS:

ID#_____

FINAL SUMMARY

Using the following ranking scale, predict the importance of the courses listed below to the electronic engineering technician in the next five years.

Very Important = 5
Important = 4
No change = 3
Little Importance = 2
Not Important = 1

_____Linear Integrated Circuits
_____Digital Communications
_____Satellite Systems
_____Telecommunications
_____Pulse & Waveshaping
_____Control Systems Theory
_____Communication Systems
_____Computer Fundamentals
_____Technical Writing
_____
_____

Please place a check mark in the category below that best describes your current position:

_____Recent technical school graduate
_____Industry EET Technician
_____Industry Electrical Engineer
_____Engineering Technology Educator
_____

This concludes the study. Check that you have placed a sequence of numbers THAT YOU WILL REMEMBER at the bottom of each of these papers. We will be giving you feedback concerning your responses in relation to the responses of the group and your identifying numbers are the only means of accomplishing this process. All identifying numbers will be listed and you must pick your own number from that list in order to determine your statistical position with the group. At that time we will ask you to reconsider your responses and to again perform some sort of ranking. It is essential that we receive the completed papers within 7 days after you have received them. Again, we appreciate your cooperation and promptness.

ID#_____

APPENDIX B

Round Two Document & Cover Letter

RESPONDENT INSTRUCTIONS

Enclosed are the materials necessary for the second, and possibly the final, Delphi round. Your prompt and excellent responses have streamlined the process considerably. We will appreciate your continued efforts.

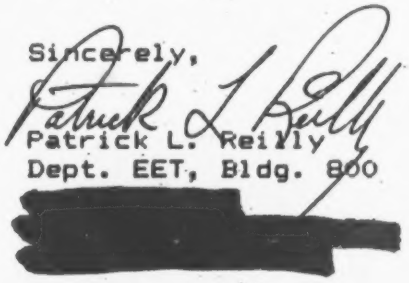
Basically, this round will follow the previously given instructions with a few minor exceptions. Please note that many of the subjects and content areas have been marked with an "X". You have indicated agreement with the other Delphi participants in these marked areas and no further ranking is required. PLEASE RANK ALL COURSES and CONTENT AREAS THAT HAVE NOT BEEN MARKED WITH AN "X". In other words, place your rank according to the scale listed next to ALL blank areas. Your responses have not agreed with the others participating for these unmarked courses and content areas. It is important that we have your opinion for these areas in order to make sound decisions. At the end of each page you will find your previously submitted comments during the first round. Please support your rankings with any additional comments you feel are necessary.

In addition to your normal ranking of courses and content areas we have placed a couple of questions on some pages for additional information-don't forget to answer these, too.

Finally, you must remember to place your **identification number** on each page. Use the same number that you used during round one. The numbers of those participating are listed below. If your number does not appear, we received your initial responses after the round one cutoff date. That does not mean, however, that your data has not been analyzed, or that you should not participate in round two. We need your input!

We are operating under heavy time restrictions and encourage you to reply promptly using the self-addressed stamped envelope enclosed. Should this indeed be the last round let me take a moment to express my appreciation for your efforts and extend to you an invitation to visit with me when in the Augusta area. I can be reached by calling (404) 796-6900 ext. 286, during normal school hours.

Sincerely,



Patrick L. Reilly
Dept. EET, Bldg. 800
[redacted]

ID NUMBERS:

133JAD 2144 54370 0370 1400 2637 11263 3030

4378 5519

FIRST YEAR

Please indicate below your answer to the question:

"What type of current flow should be used in the EET program?"

Conventional_____

Electron flow_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

CIRCUITS I X

X Electricity
X Series Circuits
X Parallel Circuits
X DC Circuit Theorems
_____Capacitance & Inductance

_____

_____

Algebra X

X Fundamental Concepts in Technical Math
X Functions & Graphs
X Linear equations & Determinants
X Factoring & Fractions
X Quadratic Equations

_____

_____

English & Composition X

X Importance of effective communication skills to the technician
_____Diction/Standard, Formal Usage
_____Parts of Speech
_____Sentence structure
_____Sentence conciseness
_____Capitalization & Punctuation
_____Paragraph structure
_____Theme construction

_____

_____

Social Science Elective
Choose from the following:

_____Economics
_____Industrial Psychology
_____Human Relations

_____

_____

ADDITIONAL COMMENTS: "Why not do AC circuits with DC?"
"Suggest English & Composition be two separate courses."
"Most of English & Composition content should have been covered in high school."

ID#_____

FIRST YEAR

Circuits II X

X Magnetism
X Inductance & Capacitance
_____ Alternating Current
_____ Reactance
_____ Impedance

Computer Fundamentals X

_____ Intro. to the Microprocessor
X Programming Concepts in BASIC
X Branching & Looping
X Arrays
_____ Functions & Subroutines
_____ Data Files
_____ Engineering Analysis Applications
_____ Graphics

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Trigonometry X

X Trig. functions of any angle
X Vectors & Triangles
X Graphs of trig. functions
X Exponents & Radicals
_____ The j-operator
_____ Properties of trig. functions
_____ Inverse trig. functions
_____ Logarithms
_____ Systems of equations

Physics I X

X Units & Measurement
X Velocity & Acceleration
X Newton's Laws
X Work & Energy
X Properties of Matter

ADDITIONAL COMMENTS:

"Computer Fundamentals material cannot be properly covered in one term."
"Circuits II must use polar-rectangular notation and include power."
"Separate into. to the microprocessor from Computer Fundamentals."

ID#_____

FIRST YEAR

Electronics I X

X Semiconductor Diodes
X Zeners & two-terminal devices
X Transistors
_____ DC Biasing
X FETs & Biasing
X BJT small-signal analysis
X FET small-signal analysis
_____ Multistage systems
_____ Large-signal amplifiers

Analytic Geometry & Calculus X

_____ Elements of Analytic Geometry
X Sequences & Series
X Derivatives
X Integration
_____ Transcendental Derivatives

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Circuit Analysis _____

_____ Complex Networks analysis
_____ Resonance
_____ Transformers

Physics II X

X Thermal properties of matter
X Gas Laws
X Basic Fluid Mechanics
_____ 1st & 2nd Laws of Thermodynamics
X Vibratory motion
X Wave motion
X Sound
X Resonance
_____ Light, Interference & Diffraction
_____ Particle Radiation

ADDITIONAL COMMENTS: "Circuit Analysis should be in Circuits II."
"Electronic I should be 2 courses or 6 hrs week for 14-15 wks."
"Applied calculus for Analytic Geo. & Calc. with no proofs."
"Include power factor in AC analysis."

ID#_____

SECOND YEAR

Electronics II X

_____PNPN and other devices
_____Integrated Circuits
_____Diff. Amps & Linear ICs
_____IC Regulators
_____Digital ICs
_____Linear Digital ICs
_____Feedback amps & Oscillators

Calculus I _____

_____Applied Derivatives
_____Higher Derivatives
_____Applied Integrals
_____Hyperbolic Functions
_____Partial Derivatives
_____Double Integrals
_____Fourier Series
_____Taylor Series
_____Maclaurin Series
_____Intro. Differential Eqs.

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Digital Electronics X

X Number Systems
X Logic Families
X Flip-Flops & Registers
X Sequential Logic Circuits
X Combinatorial logic
X Memory circuits

Technical Writing X

X Conducting Technical Research
X Planning the Technical Report
X Formal Technical Writing
X Presenting Oral Technical Reports
_____Describing Technical Processes
_____Describing Technical Mechanisms

81

ADDITIONAL COMMENTS: "ElectronicsII too diffused & heavy. Some content belongs in Linear IC course."
"Calculus I some content not appropriate."
"Tech writing should include job search processes."

ID#_____

SECOND YEAR

Please list below the types of computers you are using in your field or classroom:

_____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Microcomputer Applications I X

_____Multiplication & BCD addition
_X_Basic I/O & Interfacing
_X_Programmable peripheral chips
_____Data communications
_____Controllers

_____

_____

Linear Integrated Circuits X

_X_Intro. Op-Amps
_X_Inverting & Non-Inverting
_X_Comparators
_____Bias, Offsets & Drift
_____Bandwidth, Slew rates & Frequency compensation
_____Active Filters
_____Signal Generators

_____

_____

Technical Elective
Choose ___ from the following:

_____Anatomy & Physiology
_____Communication Systems
_____Antennas & Microwaves
_____Pulse & Waveshaping
_____Control Systems Theory

_____

_____

ADDITIONAL COMMENTS: "Micro course may belong in reg. engineering course, not in technology."
"Add modems, printers, and disc drives to Micro I."

ID#_____

SECOND YEAR

Linear Circuit Applications X

_____Power Amplifiers
_____Video Amplifiers
__X__Modulators, Demod. & Phase detectors
__X__VCOs
__X__PLLs
__X__Multipliers & Dividers
_____IC Transducers
__X__D-to-A Converters
__X__Analog switches & Sample & Hold circuits
_____CCDs
_____Special Function ICs
_____Optoelectronic ICs

_ _____

_____

Strongly Agree = 5
High Agreement = 4
Agree = 3
High Disagreement = 2
Strongly Disagree = 1

Technical Electives
Choose from the following:

_____Biomedical Instrumentation
_____Biomedical Practicum
_____Digital Communications
_____Satellite & Telecommunications
_____EET Problems
_____Microcomputer Appl. II
_____Pulse & Waveshaping
_____Control Systems Theory
_____16-bit Microprocessors

_____

_____

ADDITIONAL COMMENTS:"Cannot cover all material shown in Linear Circuits course."

ID#_____

APPENDIX C

DELPHI PARTICIPANT FINAL SURVEY

Place a check mark beside the response that best describes your answer to the following:

1. I felt that this procedure was _____ useful.

   ____not ____somewhat ____very

2. I have a good understanding of what the procedure was all about.

   ____no ____somewhat ____average ____very much

3. I feel as though my suggestions were seriously considered along with those of the other participants:

   ____no ____somewhat ____average _____very much

4. I believe that I accomplished more by this method than I would have during face-to-face meetings.

   ____no ____somewhat _____average ____very much

5. Which below best describes your level of expertise about the subject of this Delphi exercise?

   _____none ____some ____average ____very much

Please indicate any personal comments below:

_____

_____

_____

APPENDIX D

Proposed Curriculum

ELECTRONICS ENGINEERING TECHNOLOGY

FIRST QUARTER	Class	Lab	Contact hrs.	Credit hrs.
English and Composition	5	0	5	5
Algebra	5	0	5	5
D.C. Circuits	4	3	7	5
Computer Fundamentals	4	3	7	5
SECOND QUARTER				
Trigonometry	5	0	5	5
Engineering Graphics	1	6	7	3
Physics I	4	3	7	5
A.C. Circuits	4	3	7	5
THIRD QUARTER				
Analytic Geometry and Calculus	5	0	5	5
Physics II	4	3	7	5
Circuit Analysis	3	3	6	4
Electronics I (Semiconductor Analysis)	3	3	6	4
FOURTH QUARTER				
Technical Communications	5	0	5	5
Electronics II (Electronic Devices)	3	3	6	4
Digital Electronics	3	6	9	4
Elective*				
FIFTH QUARTER				
Microcomputer Applications I	4	3	7	5
Linear Integrated Circuits	4	3	7	5
Elective*				
Elective*				
SIXTH QUARTER				
Industrial Relations	5	0	5	5
Linear Applications	3	3	6	4
Elective*				
Elective*				

* Electives listed on separate page

ELECTIVES, Electronics

	Class	Lab	Contact hrs.	Credit hrs.
Anatomy and Physiology	3	3	6	4
Biomedical Instrumentation I	3	3	6	4
Biomedical Practicum	0	9	9	3
Antennas, Transmission Lines and Microwaves	3	3	6	4
Control System Theory	4	3	7	5
Pulse and Wave Shaping	3	3	6	4
Digital Communications	4	3	7	5
Satellite and Telecommunications	4	3	7	5
Microcomputer Applications II	4	3	7	5
16-Bit Microprocessors	4	3	7	5
Problems and Projects	0	9	9	3
Biomedical Instrumentation II	3	3	6	3
Communications Systems	4	3	7	5
Problems and Projects	1	12	13	5